

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application No.	:	10/566,301	Confirmation No. 2012
Applicant	:	Shiro Tsukamoto	
371 Filed	:	January 25, 2006	
Art Unit	:	1795	
Examiner	:	Jason Berman	
Customer No.	:	00270	
Title	:	SPUTTERING TARGET AND METHOD FOR FINISHING SURFACE OF SUCH TARGET	

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APPEAL BRIEF

Sir:

This is an Appeal Brief submitted in accordance with 37 CFR §41.37 within two months from the filing of October 21, 2010 of a Notice of Appeal. The appeal is taken from a FINAL rejection issued on July 22, 2010 for the above identified application.

Real Party in Interest

The real party in interest is JX Nippon Mining & Metals Corporation.

The named inventor assigned his rights in the application to Nikko Materials Co., Ltd. via assignment recorded in the U.S. Patent and Trademark Office on December 4, 2006, reel/frame: 018578/0901. A name change document recording a name change from Nikko Materials Co., Ltd. to Nippon Mining & Metals Co., Ltd. was recorded in the U.S. Patent and Trademark Office on December 8, 2006, reel/frame: 018605/0969. More recently, Nippon Mining & Metals Co., Ltd. has been merged into Nippon Mining Holdings, Inc. (merger document recorded in the U.S. Patent and Trademark Office on October 8, 2010, reel/frame: 025115/0062) and thereafter, the name of Nippon Mining Holdings, Inc. was changed to JX Nippon Mining & Metals Corporation (name change document recorded in the U.S. Patent and Trademark Office on October 12, 2010, reel/frame: 025123/0358).

Related Appeals and Interferences

There are no known prior or pending related appeals, interferences or judicial proceedings.

Status of Claims

Claims 1, 7, 9, 11-13, 16-18, 22, 24 and 27-32 are rejected.

Claims 2-6, 8, 10, 14, 15, 19-21, 23, 25 and 26 are canceled.

Appellant appeals the final rejection of claims 1, 7, 9, 11-13, 16-18, 22, 24 and 27-32.

Status of Amendments

No amendment has been filed by the Appellant or entered by the Examiner in the above referenced application since the Final Office Action dated July 22, 2010.

Summary of Claimed Subject Matter

Independent claim 1 is directed to a hollow cathode sputtering target having an inner bottom face that forms a non-erosion portion of a plastic-worked hollow cathode sputtering target and a cylindrical inner peripheral face that forms an erosion portion of the plastic-worked hollow cathode sputtering target (see FIG. 1; see page 2, lines 5-11; and see page 5, line 13, to page 6, line 2). Upon manufacture of the sputtering target, the inner bottom face of the non-erosion portion of the plastic-worked hollow cathode sputtering target has a surface roughness (Ra) of $Ra \leq 1.0 \mu m$ which is equal to or less than a surface roughness (Ra) of the cylindrical inner peripheral face of the erosion portion of the plastic-worked hollow cathode sputtering target (see page 3, line 24, to page 4, line 4; see page 4, lines 12-14; and see page 5, lines 18-26).

Independent claim 7 is directed to a method of surface finishing a hollow cathode sputtering target comprising the steps of forming a hollow body of the hollow cathode sputtering target via plastic working (see page 5, lines 15-17), and, after said plastic working, polishing and

etching an inner bottom face of the target that forms a non-erosion portion of the hollow cathode sputtering target (see page 5, lines 18-22) so as to make the surface roughness (R_a) of the inner bottom face, upon manufacture, $R_a \leq 1.0\mu\text{m}$ (see page 5, lines 18-22) and equal to or less than a surface roughness (R_a) of a cylindrical inner peripheral face of the hollow cathode sputtering target that forms an erosion portion of the hollow cathode sputtering target (see page 5, lines 23-26).

Independent claim 27 is directed to a hollow cathode sputtering target consisting of a cup-shaped body (see FIG. 1 and page 5, line 15) having an inner peripheral surface (see FIG. 1 and page 5, lines 18-19) defining a hollow cavity within the cup-shaped body and an outer peripheral surface on an exterior of said cup-shaped body (see FIG. 1 and page 6, lines 3-4). The inner peripheral surface is a sputtering face of the cup-shaped body and the outer peripheral face being a non-erosion face (see page 6, lines 3-4), and the inner peripheral surface consisting of a cylindrical peripheral face (see FIG. 1 and page 5, line 26), a bottom face (see FIG. 1 and page 5, line 20), and a curved face defining a boundary between said cylindrical face and said bottom face (see FIG. 1 and page 6, lines 10-11). The cylindrical peripheral face forms an erosion area of the sputtering face that is eroded during a sputtering operation when a high density plasma is generated within the hollow cavity of the cup-shaped body (see page 1, line 24, to page 2, line 11), and the bottom face forms a non-erosion portion of the cup-shaped body (see page 2, line 8). A surface roughness (R_a) of the bottom face, upon manufacture, is $R_a \leq 1.0\mu\text{m}$ and is less than a surface roughness (R_a) of the cylindrical inner peripheral face (see page 5, lines 18-26).

None of the claims includes a means-plus or step-plus function permitted by 35 USC §112, sixth paragraph.

Grounds of Rejection to be Reviewed on Appeal

I. Claims 1, 9, 22 and 27-31 stand rejected under 35 USC §103(a) as being obvious over U.S. Patent Application Publication No. 2004/0222088 A1 of Subramani et al. (hereinafter referred to as “Subramani et al.”) in view of U.S. Patent No. 6,139,701 issued to Pavate et al. (hereinafter referred to as “Pavate et al.”) with additional evidence provided by U.S. Patent No. 5,632,869 issued to Hurwitt et al. (hereinafter referred to as “Hurwitt et al.”).

II. Claims 1, 9, 22 and 27-31 stand rejected under 35 USC §103(a) as being obvious over Subramani et al. in view of U.S. Patent No. 6,153,315 issued to Yamakoshi et al. (hereinafter referred to as “Yamakoshi et al.”) with additional evidence provided by Hurwitt et al..

III. Claims 11-13 and 16-18 stand rejected under 35 USC §103(a) as being unpatentable over Subramani et al. in view of Pavate et al. in further view of U.S. Patent Application Publication No. 2002/0079217 A1 of Buehler (hereinafter referred to as “Buehler”).

IV. Claims 11-13 and 16-18 stand rejected under 35 USC §103(a) as being unpatentable over Subramani et al. in view of Yamakoshi et al. in further view of Buehler.

V. Claims 7, 24 and 32 stand rejected under 35 USC §103(a) as being unpatentable over Subramani et al. in view of Yamakoshi et al. and in further view of U.S. Patent No. 6,283,357 B1 issued to Kulkarni et al. (hereinafter referred to as “Kulkarni et al.”).

Argument

I. §103(a) Rejection Based on Subramani et al./Pavate et al./Hurwitt et al.

(A) Claims 1, 9, 22

Under normal circumstances, a sputtering target has an “erosion area” where the target is sputtered and a “deposition area” where sputtered atoms may be deposited. Since the “deposition area” is also an area that is not eroded, it is also a “non-erosion area”.

A phenomenon unique to a hollow cathode sputtering target is that despite the fact that the inner bottom surface of the cup faces the space where plasma is generated, occupies a large portion of the opposing area, and is in close vicinity to the cylindrical erosion surface of the target, the inner bottom surface of the cup-shaped body is not eroded at all and thus forms a non-erosion surface of the target (for example, see the disclosure provided by Kulkarni et al.). Thus, with a hollow cathode sputtering target, an “erosion area” is formed on the inner peripheral sidewall surface and a “deposition area” is formed on the inner bottom surface. A problem created by the above described phenomenon is that sputtered substances can deposit on the bottom face and then ultimately peel away from the bottom face causing the generation of particles during sputtering creating defects on the sputtered thin film. This problem with respect to peeling of re-deposited substances on the inner bottom face is unique to hollow cathode

sputtering targets due to their cup-shaped and cylindrical sidewall configuration. Tabular targets do not experience such a problem.

The concept of the present invention is to prevent re-deposited film from peeling from the “deposition area” and falling onto the opposed substrate on which a thin film is formed thereby contaminating the substrate and thin film.

Conventional teachings with respect to tabular sputtering targets include reducing the surface roughness of the erosion area of the target to improve the uniformity of the thickness of a thin film formed by a sputtering operation (see the disclosures provided by Pavate et al. and Yamakoshi et al.). In contrast, the target surface that is not eroded is roughened so that it traps substances (sputtered atoms) that are discharged from the target during the sputtering process and prevents these substances from peeling or falling off (see the disclosure provided by Buehler). The above is clearly taught by the prior art of record. Thus, it is conventional practice to roughen non-erosion portions of targets to prevent peeling. In this manner, these non-erosion portions function as a “getter” for stray particles.

Consistent with tabular targets and conventional teachings, the surface roughness of inner peripheral sidewall surfaces forming an erosion area of a hollow cathode sputtering target are reduced and the surface roughness of an inner bottom surface of a hollow cathode sputtering target is not reduced and/or is intentionally roughened since it is a “deposition area” and a non-erosion surface. Nevertheless, the inventor of the present application has determined that the uniformity of the thickness of a thin film formed during a sputtering operation with a hollow cathode sputtering target is actually reduced, sputtering becomes unstable, and more particles are generated when the inner bottom face of a hollow cathode sputtering target is roughened.

Nevertheless, Applicant has found that an unexpected result is provided by polishing the inner bottom face of a hollow body sputtering target to the extent required by the claims of the present application. The unexpected and non-obvious aspect of the present invention is that the non-roughened inner bottom face having a surface roughness equal to or less than $1.0\mu\text{m}$ or $0.5\mu\text{m}$ actually prevents peeling of re-deposited material. This is the exact opposite teaching provided by the prior art of record and clearly provides a non-obvious and unexpected result to one of ordinary skill in the art.

Thus, as a result of intense study, the present inventor discovered that film uniformity can be made to be superior from initial stages of sputtering provided the surface roughness of the inner bottom surface of the hollow cathode sputtering target is as required by claim 1 of the present application. It was also discovered that the peeling of re-deposited film is significantly reduced according to the present invention.

As described above, with conventional teachings, the practice is to roughen the “deposition area” (non-erosion area) so that substances discharged during sputtering are trapped and so that trapped substances are prevented from peeling off the deposition area. However, the present invention is completely opposite of conventional teachings, yet unexpectedly improves thickness uniformity of the thin film formed by sputtering and reduces the amount of particles resulting from material peeling from the inner bottom face.

Turning to Subramani et al. and Pavate et al., Appellant respectfully submits that it is an error to consider the sputtering targets disclosed by these references to be a cup-shaped, plastic-worked, hollow cathode sputtering target. It is not.

Paragraph No. 0021 of Subramani et al. clearly discloses the structure/configuration of the target (111) and it is clearly different than that of the present invention. The target of Subramani et al. includes separate, spaced-apart cylindrical outer and inner sidewalls (4, 6), an annular or doughnut-shaped top wall (5), and a circular top wall (9). See FIG. 1A of the Subramani et al. publication. The target (111) is said to provide an “inverted annular trough 8”. Accordingly, the target (111) disclosed by Subramani et al. is not “cup-shaped”; rather, it has an annular or doughnut-shaped trough (8).

In addition, Subramani et al. disclose an “electroplated” sputtering target. For example, see: the Title of the application publication; the Abstract (“a layer of sputtering material is electroplated ... to form the target”); Paragraph No. 0034 (“the subsequent layers 20a,b may be applied in an electroplating process”); and claim 1 (“A method of fabricating a sputtering target ... electroplating a layer of sputtering material ... thereby forming the sputtering target.”). Accordingly, as best illustrated in FIGs. 2A-2D of Subramani et al., a sputtering target formed by electroplated layers is disclosed. This is not a sputtering target having a plastic-worked structure.

Appellant respectfully submits that the annular trough sputtering target (111) of Subramani et al. neither discloses nor renders obvious the cup-shaped, plastic-worked hollow sputtering target required by the claims of the present application.

Pavate et al. disclose a copper sputtering target having a tabular sputtering face (102a). For example, see FIG. 1 of the Pavate et al. patent in which the sputtering face (102a) of the sputtering target (102) is positioned within one end of a vacuum chamber (155) directly across from and parallel to substrates (140 and 150) onto which a thin film (152) is formed from atoms

ejected from the sputtering face (102a) of the target. See column 3, line 10, to column 4, line 11, of the Pavate et al. patent for a discussion of the sputtering operation illustrated in FIG. 1.

Thus, Appellant also respectfully submits that the sputtering target of Pavate et al. neither discloses nor renders obvious the cup-shaped, plastic-worked hollow sputtering target having a cylindrical inner peripheral face forming an erosion portion of the sputtering target required by the claims of the present application.

In addition, the claims of the present application make clear that the entire inner bottom face of the cup-shaped target is a non-erosion portion of the target (this is due to its shape/configuration); whereas, in contrast, Subramani et al. (which discloses a different configuration/shape) require all surfaces, including annular top wall (5) and circular top wall (9) to comprise “the sputtering material to be sputtered on the substrate”. For example, see Paragraph No. 0021 of Subramani et al. which states that at “least a portion of the surfaces 24 of the side, top and bottom walls 4, 5, 6, 9, comprises the sputtering material to be sputtered on the substrate.” Thus, teachings provided by Subramani et al. and Pavate et al. fail to correspond or render anything obvious to one of ordinary skill in the art relative to the different target structure/configuration of the present invention as required by claim 1 of the present application. For at least this reason, Appellant respectfully requests reconsideration and removal of the above stated rejection of claims 1, 9 and 22.

Further, Subramani et al. fail to provide any meaningful description concerning the surface roughness of a non-erosion portion the hollow cathode-type sputtering target and the relative surface roughness between a non-erosion portion and an erosion portion as required by claim 1 of the present application. As stated above, due to the configuration (an annular or

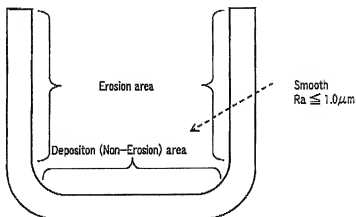
doughnut-shaped trough) of the sputtering target of Subramani et al., Subramani et al. disclose a sputtering target having surfaces including an inner annular bottom face that comprises an erosion-portion of the target. In Paragraph No. 0034 of Subramani et al., Subramani et al. state that: “Following the electroplating process, the target 111 comprising the multiple layers 12, 20a,b of sputtering material may be further machined to provide the desired dimensions and to provide a smooth target surface 24 and may also be cleansed to remove particulates from the surface 24.” This limited disclosure is the only disclosure of machining the surface of the sputtering target provided by the Subramani et al. publication. Thus, while Subramani et al. disclose that the electroplated layer of the target “may be further machined” for purposes of providing the “desired target dimensions” and a “smooth surface” (24), it should be taken into consideration that Subramani et al. provide no meaning or definition to what is meant by “smooth” and all surfaces of the target form erosion-portions of the target. Appellant respectfully submits that one of ordinary skill in the art does not learn from Subramani et al. to reduce the surface roughness of a non-erosion surface, to reduce the surface roughness of a non-erosion surface to 1.0µm or less, and to reduce the surface roughness of a non-erosion surface differently than that of an erosion surface.

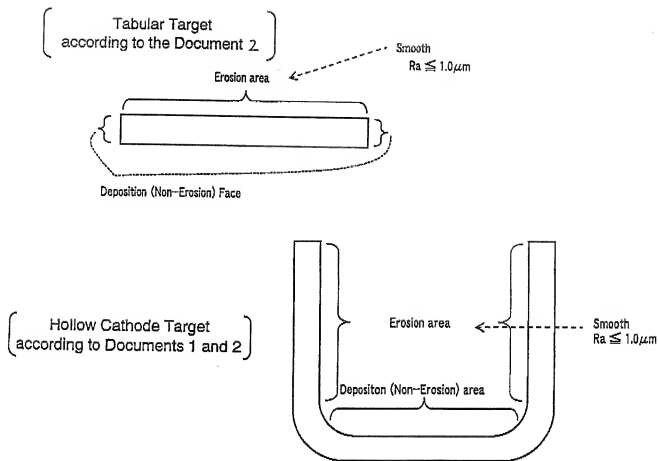
Accordingly, at best, Subramani et al. teach to one of ordinary skill in the art that the “erosion area” of a target should be made to be smooth consistent with conventional teaching. However, Appellant respectfully submits that Subramani et al. clearly do not teach, suggest, disclose or provide a common sense motivation for smoothing a “deposition area” (non-erosion area) of a cup-shaped, plastic-worked hollow cathode sputtering target.

The teaching provided by Pavate et al. is consistent with conventional teachings with respect to reducing the surface roughness of an erosion face of a tabular target. However, Pavate et al. clearly fail to teach, disclose, suggest or provide a common sense motivation for reducing the surface roughness of a “deposition area” (non-erosion surface) of a sputtering target. For at least this additional reason, Appellant respectfully requests reconsideration and removal of the above stated rejection of claims 1, 9 and 22.

The following informal sketches are submitted to clearly demonstrate the erosion and non-erosion surfaces of a hollow cathode sputtering target and a tabular target. The first sketch is directed to a hollow cathode sputtering target according to claim 1 of the present application with the deposition (non-erosion) area having a surface roughness (R_a) of less than or equal to $1.0\mu\text{m}$. Here, the erosion area is the inner annular sidewalls of the hollow cup-shaped target. The second sketch shows an example of a tabular target disclosed, for instance, by the Pavate et al. patent. Here, the surface roughness of the erosion area is reduced and the deposition or non-erosion face is roughened to catch stray particles. The third sketch is a hollow cathode sputtering target according to conventional teachings of reducing the surface roughness of the annular erosion area and roughening the surface of the deposition or non-erosion area.

(Hollow Cathode Target
according to the Present)





In addition to the above, Appellant respectfully submits that one of ordinary skill in the art would not find it obvious to modify the teachings of surface roughness of an inner bottom face of a hollow cathode target with that of a tabular target such as disclosed by the Pavate et al. patent. As discussed above, a hollow cathode sputtering target having a cup-shape and inner cylindrical peripheral surface has unique characteristics in that its inner bottom surface faces the space where plasma is generated and yet is not eroded at all since it occupies most of the area that faces the substrate and that the problem of peeling off of re-deposited particles and film from a such a bottom face caused by the unique characteristic is simply not foreseen by the structure of a tabular target. Thus, Appellant respectfully submits that the teachings of Pavate et al. provide

no meaningful and common sense teaching to one of skill in the art concerned with sputtering a hollow cathode sputtering target.

Accordingly, Appellant respectfully submits that it would not be obvious to combine the teachings of Subramani et al. with Pavate et al. and that neither reference teaches the concept of reducing the surface roughness of an inner bottom face forming a deposition and non-erosion area of a cup-shaped hollow cathode sputtering target to prevent the generation of particles caused by peeling of re-deposited particles and films from the inner bottom face.

(B) Claims 27-30

Independent claim 27 utilizes the "closed-ended" terminology of "consisting of". Thus it clearly is required to consist of a cup-shaped body having an inner peripheral surface with a cylindrical peripheral face, a bottom face, and a curved face therebetween. Pavate et al. is directed to a tabular target and Subramani et al. is directed to a sputtering target having an annular or doughnut-shaped trough. Neither reference discloses a cup-shaped target as required by claim 27.

Further claim 27 requires a surface roughness (Ra) of the bottom face, upon manufacture, to be 1.0 μ m or less and being less than a surface roughness (Ra) of the cylindrical inner peripheral face (erosion face). Thus, instead of roughened, the bottom face (deposition non-erosion face) is actually made to have a lower surface roughness than the erosion face. This is opposite to that of conventional teachings and opposite to that disclosed by the prior art of record.

In the FINAL Office Action, Hurwitt et al. is also discussed with respect to claim 27. Hurwitt et al. teach that the erosion surface of a sputtering target should be roughened prior to a sputtering operation. Accordingly, the teachings of Hurwitt et al. are entirely contrary to the teachings of Subramani et al. (all erosion surfaces smooth) and the Pavate et al. patent (reduce surface roughness of erosion portions). Accordingly, it is an error to conclude that it would be obvious for one of ordinary skill in the art to combine the opposite and contrary teachings of Hurwitt et al. with the teachings of Subramani et al. and the Pavate et al. patent. Should the surface roughness of the erosion portion be reduced according to Pavate et al. or should the surface roughness of the erosion portion be roughened according to Hurwitt et al.?

Further, Hurwitt et al. fail to provide any teaching with respect to reducing the surface roughness of a non-erosion deposition area formed by an inner bottom face of a cup-shaped hollow cathode sputtering target consisting of a cylindrical inner peripheral face, a bottom face, and a curved face which defines a boundary therebetween.

Accordingly, all the reasons for patentability discussed above with respect to independent claim 1 also apply to independent claim 27. However, independent claim 27 further distinguishes over the prior art of record based on the closed-ended "consisting of" terminology and based on the limitations requiring the non-erosion face, upon manufacture, to have a surface roughness (Ra) of 1 μ m or less and a lower surface roughness than that of the erosion surface.

For these reasons, Appellant respectfully submits that it is an error to conclude that the subject matter as claimed in claim 27 is disclosed or obvious in view of the teachings of Subramani et al. in view of Pavate et al with evidence from the contrary teachings of the Hurwitt et al. patent.

(C) Claim 31

Dependent claim 31 depends from claim 1 and further requires that the surface roughness (Ra) of the bottom face, upon manufacture, is less than a surface roughness (Ra) of the cylindrical inner peripheral face (erosion face) as well as being equal to or less than $1\mu\text{m}$. Thus, instead of roughened, the bottom face (deposition non-erosion face) is actually made to have a lower surface roughness than the erosion face. This is opposite to that of conventional teachings and opposite to that disclosed by the prior art of record.

In the FINAL Office Action, Hurwitt et al. is also discussed with respect to claim 31. Hurwitt et al. teach that the erosion surface of a sputtering target should be roughened prior to a sputtering operation. Accordingly, the teachings of Hurwitt et al. are entirely contrary to the teachings of Subramani et al. and the Pavate et al. patent. Accordingly, it is an error to conclude that it would be obvious for one of ordinary skill in the art to combine any teaching of Hurwitt et al. with that of Subramani et al. and the Pavate et al. patent. Further, Hurwitt et al. fail to provide any teaching with respect to reducing the surface roughness of a non-erosion, deposition area formed by the inner bottom face of a cup shaped hollow cathode sputtering target having a cylindrical inner peripheral face and an inner bottom face.

Accordingly, all the reasons for patentability discussed above with respect to independent claim 1 also apply to dependent claim 31. However, dependent claim 31 further distinguishes over the prior art of record based on the limitation requiring the non-erosion face, upon manufacture, to have a lower surface roughness than the erosion surface.

For this reason, Appellant respectfully submits that it is an error to conclude that the subject matter as required by claim 31 is disclosed or obvious in view of the teachings of Subramani et al. in view of Pavate et al with evidence from the Hurwitt et al. patent.

II. §103(a) Rejection Based on Subramani et al./Yamakoshi et al./Hurwitt et al.

(A) Claims 1, 9, 22

The deficiencies with respect to Subramani et al. relative to claim 1 of the present application are discussed above. All arguments cited above relative to Subramani et al. in view of Pavate et al. equally apply to the rejection based on Subramani et al. in view of the Yamakoshi et al. patent.

Yamakoshi et al. disclose controlling the surface roughness of an erosion portion of a sputtering target. However, Yamakoshi et al. fail to disclose anything relative to the surface roughness of a non-erosion, deposition area of a target such as the inner bottom face of a hollow cathode sputtering target. Thus, based on conventional teachings at the time the present inventor made his invention, one of ordinary skill in the art would have roughened non-erosion deposition areas of sputtering targets, not reduced the surface roughness of such non-erosion deposition areas to 1 μ m or less.

Thus, for all the reasons discussed above that claim 1 is patentable over Subramani et al. in view of Pavate et al., claim 1 is also patentable over Subramani et al. in view of the Yamakoshi et al. patent. Simply put, none of the cited references disclose or provide common sense reasoning for reducing the surface roughness of an inner bottom non-erosion face of a hollow cathode sputtering target to 1.0 μ m or less.

(B) Claims 27-30

The deficiencies with respect to Subramani et al. relative to claim 27 of the present application is discussed above. All arguments cited above relative to Subramani et al. in view of Pavate et al. equally apply to the rejection based on Subramani et al. in view of the Yamakoshi et al. patent with evidence from the Hurwitt et al. patent.

As discussed above, Yamakoshi et al. teaches to one of ordinary skill in the art to control the surface roughness of an erosion portion of a sputtering target. However, Yamakoshi et al. fail to disclose anything relative to the surface roughness of a non-erosion deposition area of a target such as the inner bottom face of a hollow cathode sputtering target. Thus, based on conventional teachings at the time the present inventor made his invention, one of ordinary skill in the art would have roughened non-erosion deposition areas of sputtering targets, not reduced the surface roughness of such non-erosion deposition areas to $1\mu\text{m}$ or less.

Thus, for all the reasons that claim 27 is patentable over Subramani et al. in view of Pavate et al. discussed above, claim 27 is also submitted as being patentable over Subramani et al. in view of the Yamakoshi et al. patent. Simply put, none of the cited references disclose or provide common sense reasoning for reducing the surface roughness of an inner bottom non-erosion face of a hollow cathode sputtering target to $1.0\mu\text{m}$ or less.

In the FINAL Office Action, Hurwitt et al. is discussed with respect to claim 27. Hurwitt et al. teach that the erosion surface of a sputtering target should be roughened prior to a sputtering operation. Accordingly, the teachings of Hurwitt et al. are entirely contrary to the teachings of Subramani et al. and the Yamakoshi et al. patent. Accordingly, it is an error to conclude that it would be obvious for one of ordinary skill in the art to combine any teaching of

Hurwitt et al. with that of Subramani et al. and the Yamakoshi et al. patent. Further, Hurwitt et al. fail to provide any teaching with respect to reducing the surface roughness of a non-erosion, deposition area formed by the inner bottom face of a cup shaped hollow cathode sputtering target consisting of a cylindrical inner peripheral face, a bottom face, and a curved face defining a boundary therebetween.

For these reasons, Appellant respectfully submits that it is an error to conclude that the subject matter as claimed in claim 27 is disclosed or obvious in view of the teachings of Subramani et al. in view of Yamakoshi et al. with evidence from the Hurwitt et al. patent.

(C) Claim 31

The deficiencies with respect to Subramani et al. relative to claim 31 of the present application are discussed above. All arguments cited above relative to Subramani et al. in view of Pavate et al. equally apply to the rejection based on Subramani et al. in view of the Yamakoshi et al. patent with evidence from the Hurwitt et al. patent.

Yamakoshi et al. disclose controlling the surface roughness of an erosion portion of a sputtering target. However, Yamakoshi et al. fail to disclose anything relative to the surface roughness of a non-erosion deposition area of a target, such as the inner bottom face of a hollow cathode sputtering target. Thus, based on conventional teachings at the time the present inventor made his invention, one of ordinary skill in the art would have roughened non-erosion deposition areas of sputtering targets, not reduced the surface roughness of such non-erosion deposition areas to 1 μ m or less.

Thus, for all the reasons that claim 31 is patentable over Subramani et al. in view of Pavate et al. discussed above, claim 31 is also submitted as being patentable over Subramani et al. in view of the Yamakoshi et al. patent. Simply put, none of the cited references disclose or provide common sense reasoning for reducing the surface roughness of an inner bottom non-erosion face of a hollow cathode sputtering target to 1.0 μ m or less.

In the FINAL Office Action, Hurwitt et al. is also discussed with respect to claim 31. Hurwitt et al. teach that the erosion surface of a sputtering target should be roughened prior to a sputtering operation. Accordingly, the teachings of Hurwitt et al. are entirely contrary to the teachings of Subramani et al. and the Yamakoshi et al. patent. Accordingly, it is an error to conclude that it would be obvious for one of ordinary skill in the art to combine the contrary teaching of Hurwitt et al. with that of Subramani et al. and the Yamakoshi et al. patent. Further, Hurwitt et al. fail to provide any teaching with respect to reducing the surface roughness of a non-erosion deposition area formed by the inner bottom face of a cup shaped hollow cathode sputtering target having a cylindrical inner peripheral face and a bottom face.

For these reasons, Appellant respectfully submits that it is an error to conclude that the subject matter as claimed in claim 31 is disclosed or obvious in view of the teachings of Subramani et al. in view of Yamakoshi et al. with evidence from the Hurwitt et al. patent.

III. §103(a) Rejection Based on Subramani et al./Pavate et al./Buehler

Claims 11-13 and 16-18

Appellant respectfully submits that claims 11-13 and 16-18, which depend from base independent claim 1, are patentable over Subramani et al. in view of Pavate et al. for all the reasons discussed above with respect to claim 1 being patentable over these references.

However, it should be noted that Buehler teaches to one of ordinary skill in the art that the non-erosion or deposition areas of a tabular sputtering target and/or backing plate should be roughened with an imprinted repeating pattern. The problems with respect to re-deposited particles and need to roughen such surfaces are discussed in Paragraph No. 0031 of Buehler. Appellant respectfully submits that one of ordinary skill in the art relying on Buehler would certainly roughen non-erosion surfaces of sputtering targets according to the teachings of Buehler. It would certainly not be obvious from the teachings of Buehler to reduce the surface roughness (Ra) of a non-erosion deposition area of a sputtering target to 1 μ m or less. Of course, the inner bottom surface of a hollow cathode sputtering target is a non-erosion deposition surface. Thus, one of ordinary skill in the art following the teachings of Buehler at the time the present invention was made would have certainly followed Buehler's teachings to roughen with imprints such a non-erosion surface.

For this additional reason, Appellant respectfully submits that claims 11-13 and 16-18 would not be obvious over Subramani et al. in view of Pavate et al. in further view of Buehler. Such a combination would lead one of ordinary skill in the art to reduce the surface roughness of erosion areas (Pavate et al.) of the sputtering targets and roughen non-erosion deposition areas (Buehler).

IV. §103(a) Rejection Based on Subramani et al./Yamakoshi et al./Buehler

Claims 11-13 and 16-18

Appellant respectfully submits that claims 11-13 and 16-18, which depend from base independent claim 1, are patentable over Subramani et al. in view of Yamakoshi et al. for all the reasons discussed above with respect to claim 1 being patentable over these references.

However, it should be noted that Buehler teaches to one of ordinary skill in the art that the non-erosion or deposition areas of a tabular sputtering target and/or backing plate should be roughened with an imprinted repeating pattern. The problems with respect to re-deposited particles and need to roughen such surfaces are discussed in Paragraph No. 0031 of Buehler. Appellant respectfully submits that one of ordinary skill in the art relying on Buehler would certainly roughen non-erosion surfaces of sputtering targets according to the teachings of Buehler. It would certainly not be obvious to reduce the surface roughness (Ra) of a non-erosion deposition area of a sputtering target. Of course, the inner bottom surface of a hollow cathode sputtering target is a non-erosion deposition surface. Thus, one of ordinary skill in the art following the teachings of Buehler at the time the present invention was made would have certainly followed Buehler's teachings to roughen with imprints such a non-erosion surface.

For this additional reason, Appellant respectfully submits that claims 11-13 and 16-18 would not be obvious over Subramani et al. in view of Yamakoshi et al. in further view of Buehler. Such a combination would lead one of ordinary skill in the art to reduce the surface roughness of erosion areas of the sputtering targets and roughen non-erosion deposition areas. In contrast, the present invention requires the non-erosion deposition area of the inner bottom surface to have a surface roughness (Ra) reduced to 1.0 μ m or less, not roughened with imprints.

V. §103(a) Rejection Based on Subramani et al./Yamakoshi et al./Kulkarni et al.

(A) Claims 7 and 24

Claims 7 and 24 are method claims and require the step of making, upon manufacture, the surface roughness (Ra) of an inner bottom face (non-erosion face) of a hollow cathode sputtering target 1.0µm or less and equal or less than a surface roughness (Ra) of a cylindrical inner peripheral face (erosion face) of the target.

Subramani et al. is discussed above in detail with respect to the rejection of claim 1. Subramani et al. is not a hollow cathode sputtering target and is not subject to plastic working. Yamakoshi et al. relates to reducing the surface roughness (Ra) of an erosion surface, not a non-erosion surface. Kulkarni et al. disclose that the erosion portion of a hollow cathode sputtering target is a "racetrack region" in a narrow ring-shaped region in the inner sidewall of the sputtering target. See column 1, lines 64-66, of the Kulkarni et al. patent.

According to the above teachings, one of ordinary skill in the art at the time the present invention was made applying common sense would have reduced the surface roughness of the "racetrack" erosion portion of the inner sidewall face of a hollow cathode sputtering target. One of ordinary skill in the art, particularly in view of the teachings of Kulkarni et al., would have realized the inner bottom face is a non-erosion/deposition portion of a cathode sputtering target and would have been provided with no reason to reduce the surface roughness (Ra) of such a non-erosion/deposition region to 1µm or less. Following conventional teachings (such as provided by Buehler), such a non-erosion/ deposition region would have been roughened.

Accordingly, Appellant respectfully submits that independent method claim 7 of the present application is not obvious over Subramani et al. in view of Yamakoshi et al. and further

in view of the Kulkarni et al. patent. The concept of reducing surface roughness (Ra) of the inner bottom surface of plastic-worked, cup-shaped, hollow cathode sputtering target is simply not disclosed or rendered obvious based on any teachings of the above referenced prior art.

(B) Claim 32

Claims 32 requires the step of making, upon manufacture, the surface roughness (Ra) of an inner bottom face (non-erosion face) of a hollow cathode sputtering target $1.0\mu\text{m}$ or less and less than a surface roughness (Ra) of a cylindrical inner peripheral face (erosion face) of the target.

As discussed above, Yamakoshi et al. teach that the surface roughness of the erosion surface should be reduced, not the non-erosion surface, and Kulkarni et al. specifically teach that the erosion surface of a cup-shaped hollow sputtering target is a racetrack region in the inner peripheral sidewall of the sputtering target. Thus, according to these teachings, one of ordinary skill in the art relying on common sense would reduce the surface roughness of the erosion surface, not the non-erosion surface which in this case is the inner bottom face of the hollow cathode sputtering target.

Accordingly, Appellant respectfully submits that method claim 32 of the present application is not obvious in view of Subramani et al. in view of Yamakoshi et al. and further in view of the Kulkarni et al. patent. The concept of reducing surface roughness (Ra) of the inner bottom surface of plastic-worked, cup-shaped, hollow cathode sputtering target is simply not disclosed or rendered obvious based on any teachings of the above referenced prior art.

Summary

For the reasons stated above, it is submitted that the final rejection of claims 1, 7, 9, 11-13, 16-18, 22, 24 and 27-32 should be reversed.

Payment of \$540 for the required fee under 37 CFR §41.20(b)(2) is charged to our deposit account No. 08-3040. Please charge any deficiency in the fee submitted for this brief to our deposit account 08-3040.

Respectfully submitted,
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Enclosures:

(a) appendix with copy of claims on appeal

CLAIMS APPENDIX

COPY OF CLAIMS INVOLVED IN THE APPEAL

Claim 1 (previously presented): A hollow cathode sputtering target comprising an inner bottom face that forms a non-erosion portion of a plastic-worked hollow cathode sputtering target and a cylindrical inner peripheral face that forms an erosion portion of the plastic-worked hollow cathode sputtering target, wherein, upon manufacture, a surface roughness (Ra) of said inner bottom face of said non-erosion portion of the plastic-worked hollow cathode sputtering target being $Ra \leq 1.0 \mu m$ and being equal to or less than a surface roughness (Ra) of said cylindrical inner peripheral face of said erosion portion of the plastic-worked hollow cathode sputtering target.

Claims 2-6 (canceled).

Claim 7 (previously presented): A surface finishing method of a hollow cathode sputtering target comprising the steps of forming a hollow body of the hollow cathode sputtering target via plastic working, and, after said plastic working, polishing and etching an inner bottom face of the target that forms a non-erosion portion of the hollow cathode sputtering target so as to make the surface roughness (Ra) of the inner bottom face, upon manufacture, $Ra \leq 1.0 \mu m$ and equal to or less than a surface roughness (Ra) of a cylindrical inner peripheral face of the hollow cathode sputtering target that forms an erosion portion of the hollow cathode sputtering target.

Claim 8 (canceled).

Claim 9 (previously presented): A hollow cathode sputtering target according to claim 1, wherein said surface roughness of said inner bottom face of said non-erosion portion of the hollow cathode sputtering target is $Ra \leq 0.5 \mu m$.

Claim 10 (canceled).

Claim 11 (previously presented): A hollow cathode sputtering target according to claim 9, wherein said target has an outer peripheral edge with a rough face and wherein said outer peripheral edge forms part of said non-erosion portion of the hollow cathode sputtering target.

Claim 12 (previously presented): A hollow cathode sputtering target according to claim 11, wherein said rough face of said outer peripheral edge is an abrasive blasted face.

Claim 13 (previously presented): A hollow cathode sputtering target according to claim 12, wherein said hollow cathode sputtering target is formed from a cladding material.

Claims 14-15 (canceled).

Claim 16 (previously presented): A hollow cathode sputtering target according to claim 1, wherein said target has an outer peripheral edge with a rough face and wherein said outer peripheral edge forms part of said non-erosion portion of the hollow cathode sputtering target.

Claim 17 (previously presented): A hollow cathode sputtering target according to claim 16, wherein said rough face of said outer peripheral edge is an abrasive blasted face.

Claim 18 (previously presented): A hollow cathode sputtering target according to claim 17, wherein said hollow cathode sputtering target is formed from a cladding material.

Claims 19-21 (canceled).

Claim 22 (previously presented): A hollow cathode sputtering target according to claim 1, wherein said hollow cathode sputtering target is formed from a cladding material.

Claim 23 (canceled).

Claim 24 (previously presented): A method according to claim 7, wherein said surface roughness of said inner bottom face is made to be $Ra \leq 0.5 \mu\text{m}$ during said polishing and etching step.

Claims 25-26 (canceled)

Claim 27 (previously presented): A hollow cathode sputtering target, consisting of:
a cup-shaped body having an inner peripheral surface defining a hollow cavity
within the cup-shaped body and an outer peripheral surface on an exterior

of said cup-shaped body, said inner peripheral surface being a sputtering face of said cup-shaped body and said outer peripheral face being a non-erosion face;

said inner peripheral surface consisting of a cylindrical peripheral face, a bottom face, and a curved face defining a boundary between said cylindrical face and said bottom face, said cylindrical peripheral face forming an erosion area of said sputtering face that is eroded during a sputtering operation when a high density plasma is generated within the hollow cavity of the cup-shaped body, and said bottom face forming a non-erosion portion of said cup-shaped body;

a surface roughness (Ra) of said bottom face, upon manufacture, being $Ra \leq 1.0 \mu\text{m}$ and being less than a surface roughness (Ra) of said cylindrical inner peripheral face.

Claim 28 (previously presented): A hollow cathode sputtering target according to claim 27, wherein said surface roughness of said bottom face is $Ra \leq 0.5 \mu\text{m}$.

Claim 29 (previously presented): A hollow cathode sputtering target according to claim 27 wherein said cup-shaped body is made of titanium (Ti).

Claim 30 (previously presented): A hollow cathode sputtering target according to claim 27 wherein said cup-shaped body is made of tantalum (Ta).

Claim 31 (previously presented): A hollow cathode sputtering target according to claim 1, wherein said surface roughness (Ra) of said inner bottom face, upon manufacture, is less than said surface roughness (Ra) of said cylindrical inner peripheral face.

Claim 32 (previously presented): A method according to claim 7, wherein, during said polishing and etching step, the surface roughness (Ra) of the inner bottom face, upon manufacture, is made to be less than the surface roughness (Ra) of the cylindrical inner peripheral face.

EVIDENCE APPENDIX - none

RELATED PROCEEDING APPENDIX - none